BRAIN DUMP

YOUR
REGULAR DOSE OF
INCREDIBLE
FACTS

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HOW IT WORKS

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HOW IT WORKS

WELCOME

GET YOUR CURIOUS QUESTIONS ANSWERED

Congratulations! Another issue of Brain Dump has been delivered direct to your tablet or smartphone. As usual, it's packed with facts, stats and info encompassing a fascinating range of topics from the worlds of science, space, nature, transport and the human body. Give your brain a workout and swipe left to get started.

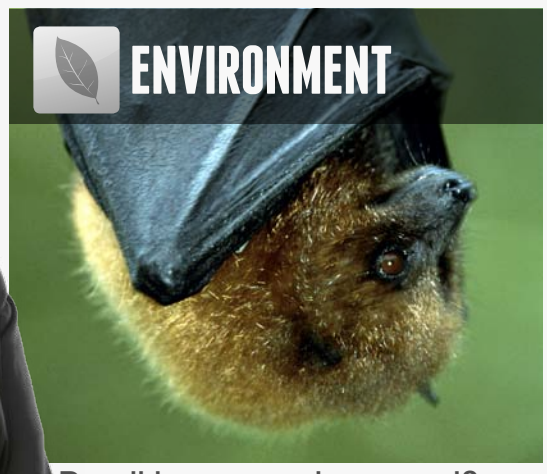
The Braindump Team

How do drugs affect spiders?

Do we age differently in space?

Who invented the barometer?

Explore VTOL drones



Do all bats use ultrasound?

Why voice recordings sound different

FOLLOW US ON...

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THAT'S AMAZING

A birdwatcher in Israel captured the moment a bird killed a bat by hitting it against branches, and then attempted to swallow it. The bird was, however, unsuccessful in having the bat for its dinner.

THAT`S AMAZING

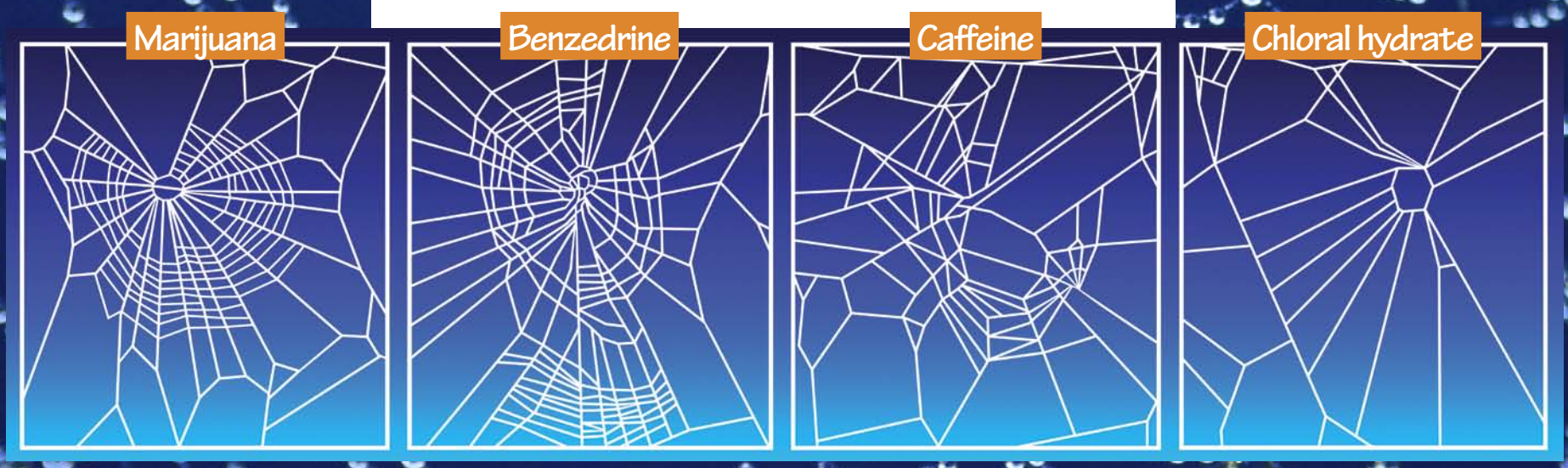
The world's largest 3D printer, BigDelta, is 12 metres (39 feet) tall and was constructed by Italian enterprise WASP. It is expected to be used to build sustainable and affordable housing in developing countries.

THAT'S AMAZING

A well-camouflaged gecko was hiding in a tree on Nosy Mangabe Island off the coast of Magagascar, when it surprised a photographer by jumping up and pulling a Kermit-esque face!

HOW DO DRUGS AFFECT SPIDER WEBS?

To test psychological effects of caffeine and some common drugs, scientists administered them to spiders to see how they impacted on web construction. The most famous experiment was conducted by NASA in the Nineties. While marijuana led to slowly spun, incomplete webs and benzedrine ('speed') led to fast-spun, poorly organised webs, it was caffeine that had the biggest effect. It almost completely stopped spiders spinning webs at all.



DO WE AGE DIFFERENTLY IN SPACE?

Sort of – the lack of gravity on board orbiting spacecraft has some effects that are very much like an accelerated form of ageing. For example, muscles begin to waste away with lack of exercise, and the strength of your bones deteriorates in a very similar way to the effects of osteoporosis. Your heart also becomes less efficient because it doesn't have to pump blood against gravity. Fortunately, these effects are easily reversed on return to Earth. Ironically, though, travel at high speeds means that, through the strange effects of Einstein's theory of relativity, astronauts do actually experience time passing slightly more slowly than those of us on Earth.

WHY DO MATERIALS HAVE DIFFERENT BOILING AND MELTING POINTS?

The boiling and melting points of a substance depend on the strength of the bonds holding its molecules or ions together. In ice, for example, relatively weak bonds connect H_2O molecules to their neighbours. As you increase the temperature to zero degrees Celsius (32 degrees Fahrenheit), the molecules vibrate faster and faster until these bonds break, leaving the molecules bound very loosely as liquid water. The bonds holding together ions inside metals, on the other hand, are very strong. It therefore takes a lot of energy and very high temperature to cause metals to melt.

5 COOL THINGS ROCKETS

1 Robert Goddard built and launched the first liquid-fuel rocket on 16 March 1926. It was fuelled by gasoline and liquid oxygen, the flight lasting two and a half seconds.

2 In 1232 BCE, the Chinese used rocket-arrows propelled by burning gunpowder in their war with the Mongols. While not very effective, they were likely a frightening sight.

3 On 4 Oct 1957, the R-7 ICBM was the first rocket to launch an artificial satellite – Sputnik 1 – into orbit. This marked the start of the Space Race between the US and the USSR.

4 SpaceX, a company pioneering commercial space travel, launched its first Falcon 9 rocket on 4 June 2010 from Cape Canaveral.

5 Germany launched the first rocket capable of reaching space, the V-2 rocket, in 1942. The missile was aimed at sites in England and Belgium as part of the WWII effort.

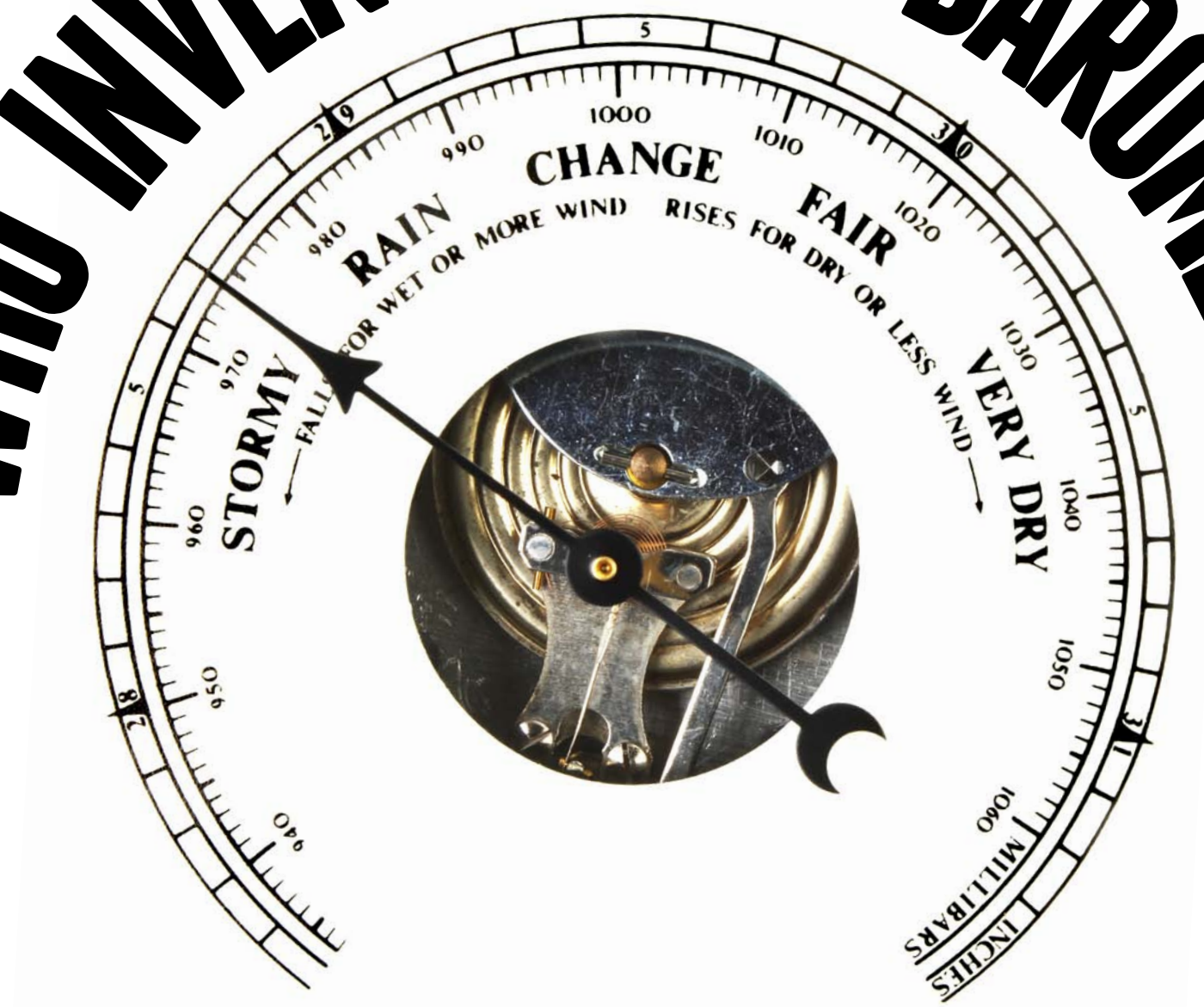
WHY DO WE YAWN?

Until recently, the most popular explanation was that yawning increased the supply of oxygen to the brain. However, there is mounting scientific evidence to suggest that yawning has more to do with temperature than oxygen. As brain temperature rises, concentration and memory suffer, and a number of tests in humans and animals have shown that yawning is linked to heat, and increases when our brains are getting too warm. By taking a deep breath of cool air, brain temperature drops back down, increasing alertness.

WHAT ARE SINKHOLES?

Sinkholes form when water slowly erodes the bedrock underground, until the surface is no longer supported and collapses into the cavity beneath. This occurs most commonly in areas where the bedrock is made of salt or carbonate rocks (such as gypsum or limestone), which are particularly susceptible to dissolving. In the absence of surface drainage, water accumulates in the sinkhole, draining through to the subsurface. Cover-subsidence sinkholes create a small depression at the surface, which sinks slowly. Cover-collapse sinkholes are far more dramatic, collapsing in a matter of just a few hours and potentially causing catastrophic damage. One of the most spectacular sinkholes ever seen opened up in Guatemala City in 2010, swallowing a three-storey building. It measured 20 metres (66 feet) across and had a depth of 30 metres (98 feet). Sinkholes are a natural phenomenon, but manmade changes to drainage flows (such as ground pumping) or land use changes can encourage them to occur.

WHO INVENTED THE BAROMETER?



Evangelista Torricelli became court scientist to the Duke of Tuscany in 1642. In 1644 Torricelli described how he took a glass tube about one metre (3.3 feet) long, sealed at one end, and filled it with mercury, which is denser than water. Holding his finger over the open end of the tube, he inverted it under the mercury contained in a large bowl and removed his finger. The mercury fell to 76 centimetres (30 inches) above the mercury level in the bowl where it stayed. This is called Torricelli's experiment. The space at the top of the tube above the mercury in barometers is called the Torricellian vacuum.

WHAT IS IT?

SWIPE TO REVEAL

RED-LIPPED BATFISH

The rather unusual Red-lipped batfish can be found at depths of 30 metres (98 feet) or more around the Galapagos Islands. Batfish use their pectoral fins to transport themselves along the ocean floor, and look as though they are walking! They are not very good swimmers, and have a structure on their heads, known as illicium, which is used to attract prey.

HOW DO ELECTRIC FREEZERS GET SO COLD?

A freezer achieves a temperature of about -22 degrees Celsius (-7.6 degrees Fahrenheit) by using a gas, such as tetrafluoroethane, that has a boiling point not too far below 0 degrees Celsius (32 degrees Fahrenheit). The freezer compresses the coolant, which heats it, then passes the hot vapour around the coils at the back. Heat radiates from the coils to the room, and the coolant temperature drops. As the coolant is under pressure, it condenses. Then it is pumped to the interior of the freezer and a pressure valve lets about half the coolant boil off. This drops the temperature of the rest of the coolant, allowing heat to flow from the freezer compartment to the coolant. Once boiled off, it returns to the compressor in order to restart the cycle. Vapour compression cycling using different gases can achieve much lower temperatures (around -269 degrees Celsius / -452 degrees Fahrenheit). Below that you can use a laser to reach temperatures a fraction of a degree above absolute zero.

DO ALL BATS USE ULTRASOUND?

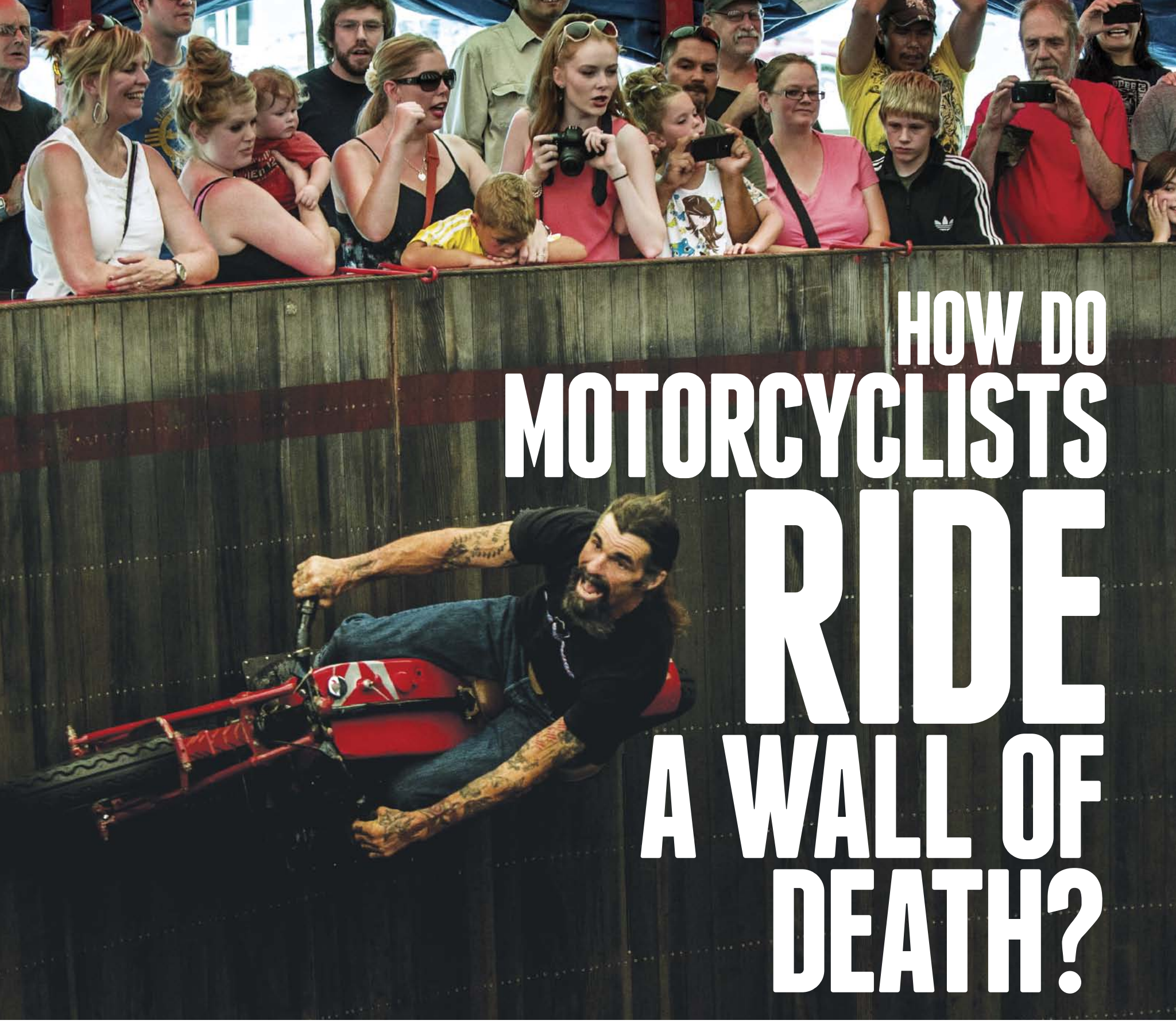
No. All of the mouse-sized microbats use ultrasound calls for echolocation but fruitbats and flying foxes (megabats) have lost this ability. Although we can't hear it, echolocation requires bats to scream at 130 decibels! That takes a lot of energy but the microbats are able to harness some of the muscular effort from their wingbeats to generate the air pressures needed for their calls. Megabats flap their wings too slowly for this to work and considering that flying is already more tiring for them because they are heavier, it makes echolocation too exhausting to be worth it.

COULD WE EVER VISIT A MULTIVERSE?

Models of the universe's inflation predict that other universes may exist alongside our own, but it is likely the physics governing a parallel universe would be incompatible with our own. For instance, other universes could have more or fewer dimensions, filled with different types of matter and constrained by different forces, meaning we simply could not exist there. Some forces such as gravity, could be shared across the multiverse, perhaps making it possible to communicate via gravitational effects. Wormholes, forming 'shortcuts' connecting two separate points in space-time, are predicted by the theory of relativity, but they would be microscopic in size and very unstable, unless we were able to find a way to modify them. But the first step for anyone planning a trip to another universe would be to find evidence for their existence.

WHY DOES MY VOICE SOUND DIFFERENT ON A RECORDING?

A recording only captures part of the sound of your voice – the part that travels through the air to the microphone. This is the same as the sound that reaches the ears of everyone else, so the recording sounds just like your real voice to them. But when we normally hear our own voices, the sound is a combination of this airborne sound, and the sound that travels through the bones of our jaw and skull. This favours the lower sound frequencies, so we all hear our voices as deeper and more resonant than the rest of the world does.



HOW DO MOTORCYCLISTS RIDE A WALL OF DEATH?

The Wall of Death – also known as the motordrome or silodrome – is a barrel-shaped cylinder, usually made out of wood. Motorcyclists perform stunts while riding on the vertical wall. The Wall of Death is a popular travelling carnival act dating from the early-20th century, but there are just a few left today. The motorcyclist starts at the bottom with the crowd looking down into the drum. After ascending a ramp to gain speed, they then begin circling the vertical wall, held in place by centripetal force. There are three forces working on the motorcyclist: gravity, the wall and friction. The motorcyclist must maintain a constant speed to keep the vehicle's direction of motion constantly changing. They must also lean up at an angle (with respect to the wall) while riding to keep the bike's torque at zero. This impressive feat occasionally results in accidents if the rider gets too close to the top of the wall or fails to maintain the speed or angle necessary to stay up.

CAN OPERA SINGERS SHATTER GLASS?

This is possible, but not likely! All objects have a frequency at which they naturally vibrate. Sound waves from the singer's voice vibrate air molecules surrounding the glass, causing the glass to vibrate. This is known as resonance. The glass would need microscopic defects big enough to buckle under the pressure. The chances of finding such a glass are slim, particularly as the fractures can't be seen by the naked eye. The note must also match the glass's resonant frequency.

Man-Made Marvels

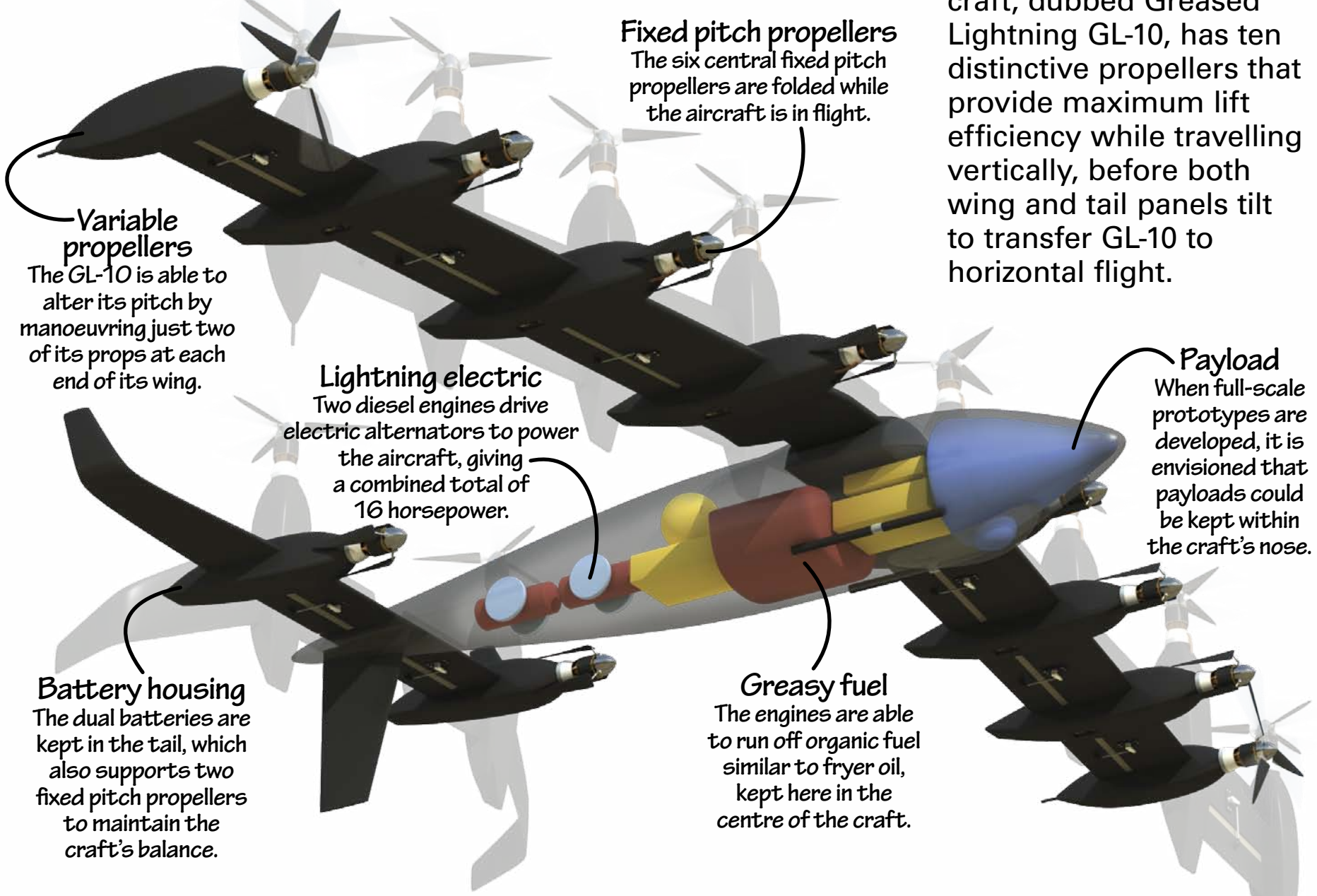
VTOL drones

From the humble helicopters of yesterday, to the robotic drones of tomorrow, vertical lift technology is on the rise

SWIPE FOR MORE

NASA'S VTOL DRONE

NASA's hybrid-electric craft, dubbed Greased Lightning GL-10, has ten distinctive propellers that provide maximum lift efficiency while travelling vertically, before both wing and tail panels tilt to transfer GL-10 to horizontal flight.



Fixed pitch propellers
The six central fixed pitch propellers are folded while the aircraft is in flight.

Variable propellers
The GL-10 is able to alter its pitch by manoeuvring just two of its props at each end of its wing.

Lightning electric
Two diesel engines drive electric alternators to power the aircraft, giving a combined total of 16 horsepower.

Payload
When full-scale prototypes are developed, it is envisioned that payloads could be kept within the craft's nose.

Battery housing
The dual batteries are kept in the tail, which also supports two fixed pitch propellers to maintain the craft's balance.

Greasy fuel
The engines are able to run off organic fuel similar to fryer oil, kept here in the centre of the craft.

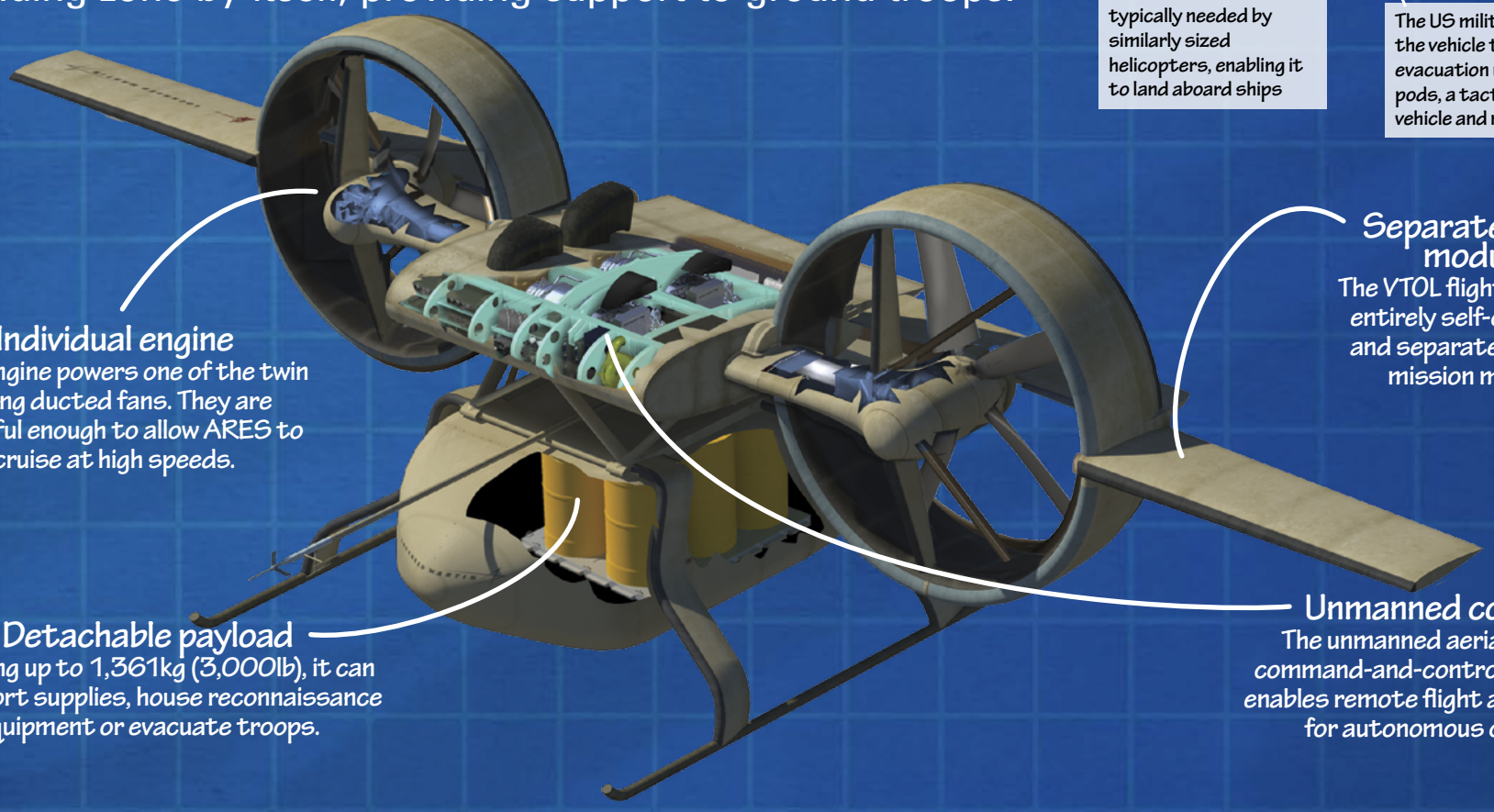
UNMANNED VTOL GOES TO WAR

DARPA turned to unmanned VTOL drones. The ARES design can carry a range of payloads, from supplies to reconnaissance equipment, to evacuated casualties.

An onboard computer can select optimal routes from its home base to the troops in the field. It will even select a landing zone by itself, providing support to ground troops.

ARES can use landing zones half the size typically needed by similarly sized helicopters, enabling it to land aboard ships

The US military can adapt the vehicle to medical evacuation units, cargo pods, a tactical ground vehicle and more



Individual engine
Each engine powers one of the twin tilting ducted fans. They are powerful enough to allow ARES to cruise at high speeds.

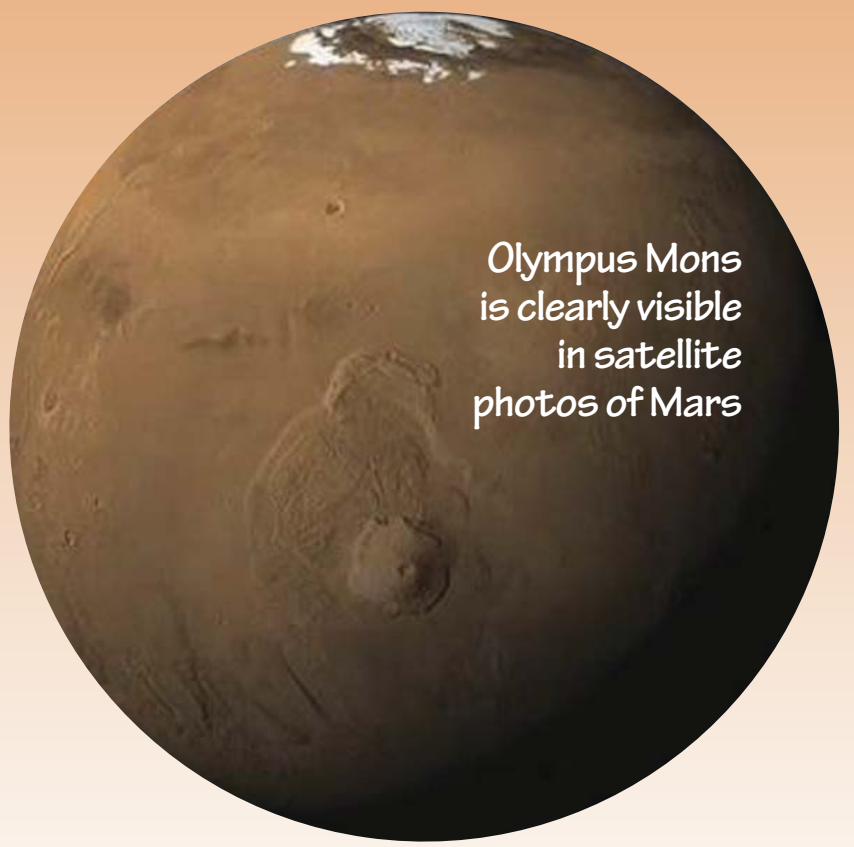
Separate flight module
The VTOL flight module is entirely self-contained and separate from the mission module.

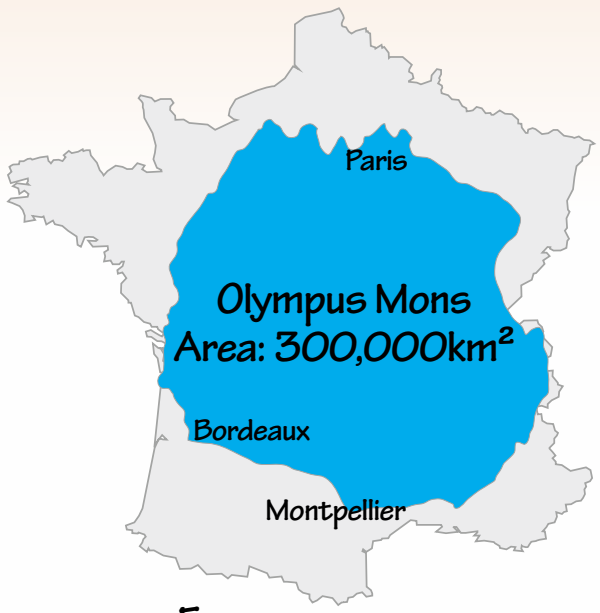
Detachable payload
Weighing up to 1,361kg (3,000lb), it can transport supplies, house reconnaissance equipment or evacuate troops.

Unmanned control
The unmanned aerial system command-and-control interfaces enables remote flight and potential for autonomous control.

HOW BIG IS OLYMPUS MONS?

The biggest mountain in the Solar System is Olympus Mons, a 26-kilometre (16-mile) high shield volcano on the planet Mars. This makes it an incredible two-and-a-half times the size of the tallest mountain on Earth, Mauna Kea, and just under three times the height of Mount Everest. Not only is it tall, Olympus Mons is also incredibly wide, stretching 624 kilometres (388 miles) across its base. This enormous geological feature has been steadily building up longer than life has existed on Earth. As these numbers are pretty tricky to get your head around, we've put together some handy comparisons so you can fully appreciate just how impressive Olympus Mons is.



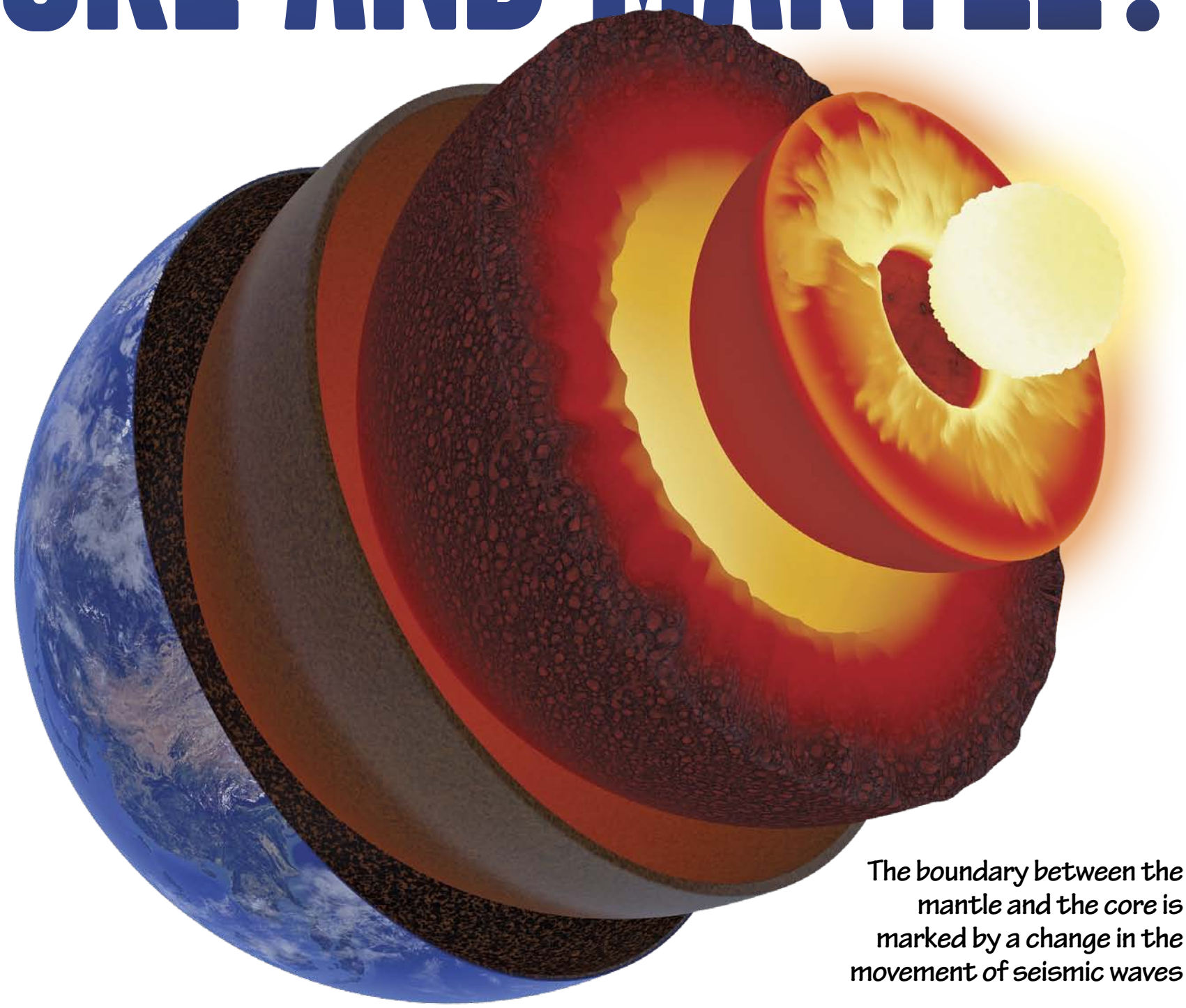


France
Area: 640,679km²

VOLUME

Even though Olympus Mons may look impressive on the surface, underneath it is just as fascinating. At 4 million cubic kilometres (959,650 cubic miles), the volume of Olympus Mons is 100 times that of Mauna Loa, Earth's biggest volcano (by volume). It would hold a staggering 1.6 billion Great Pyramids and 50 times the volume of the Caspian Sea, Earth's largest lake.

IS THERE A BOUNDARY BETWEEN CORE AND MANTLE?



The boundary between the mantle and the core is marked by a change in the movement of seismic waves

There seems to be a very definite transition at a depth of around 2,900 kilometres (1,802 miles), known as the core-mantle boundary. We don't know for sure what is going on inside our planet, but by looking at how seismic waves travel through the Earth, scientists have a pretty good idea. Secondary seismic waves (known as S-waves) cannot travel through liquids, and at the core-mantle boundary they abruptly disappear, indicating that they have moved from a solid (the mantle) into a liquid (the core). The boundary region contains patches known as ultra-low velocity zones, which are thought to contain high levels of iron that make them very compressible, giving them their strange wave-slowing properties.

WHY AREN'T MONGOOSES AFRAID OF SNAKES?

Mongooses are resistant to snake venom. A main constituent of the venom is a toxin that mimics the shape of the neurotransmitter acetylcholine. If bitten, venom attaches to receptor sites on nerve cells and blocks normal action of acetylcholine. Mongooses have a different molecular shape to their receptor site so acetylcholine still binds to it correctly but snake venom does not.

WHY CAN WE SEE THE MOON IN THE DAYTIME?

The Moon is the second-brightest object in the sky and incredibly reflective of the Sun's rays, so the reflected light can penetrate the scattered blue light of the sky. The Sun and Moon are only opposite each other in the sky when the Moon is at its full stage. In theory, the Moon is almost always visible in daytime, except when it's too close to the Sun (a new moon) or too far away (a full moon).

AMAZING SCIENCE EXPERIMENTS

THAT YOU CAN DO AT HOME

GIANT TOOTHPASTE

EQUIPMENT

Empty plastic bottle
Tray
Food colouring
Dry yeast
Hot water
Washing-up liquid
Hydrogen peroxide solution (3-6% concentration from a pharmacy)

1. Pour about two tablespoons of hydrogen peroxide into the bottom of an empty plastic bottle. Add food colouring for aesthetic effects, and a tablespoon of washing-up liquid as well.

2. Mix one tablespoon of yeast with two of hot – but not boiling – water.

3. Pour your yeast mixture into the bottle, but get ready because you're about to see the reaction in action.

4. You'll see the liquid in the bottle will now rise up and turn into a thick foam, safe to touch but not to ingest.

WHAT HAVE YOU LEARNED?

The main thing to note from this experiment is that the hydrogen peroxide is being made to decompose into oxygen and water very quickly, much more so than it would naturally if left to stand. This is made possible by adding a catalyst, in this case yeast. This catalyst breaks the hydrogen peroxide down rapidly, resulting in a lot of oxygen and water being produced. By adding soap to this reaction, the release of oxygen turns the soapy water into a multitude of tiny bubbles that resemble foam. These bubbles have nowhere to go and so they fire out of the bottle. The more concentrated the hydrogen peroxide is, the more oxygen it contains, releasing more of it when the reaction occurs and resulting in a more violent or larger reaction.

ANATOMY OF

16TH-CENTURY SPANISH GALLEON

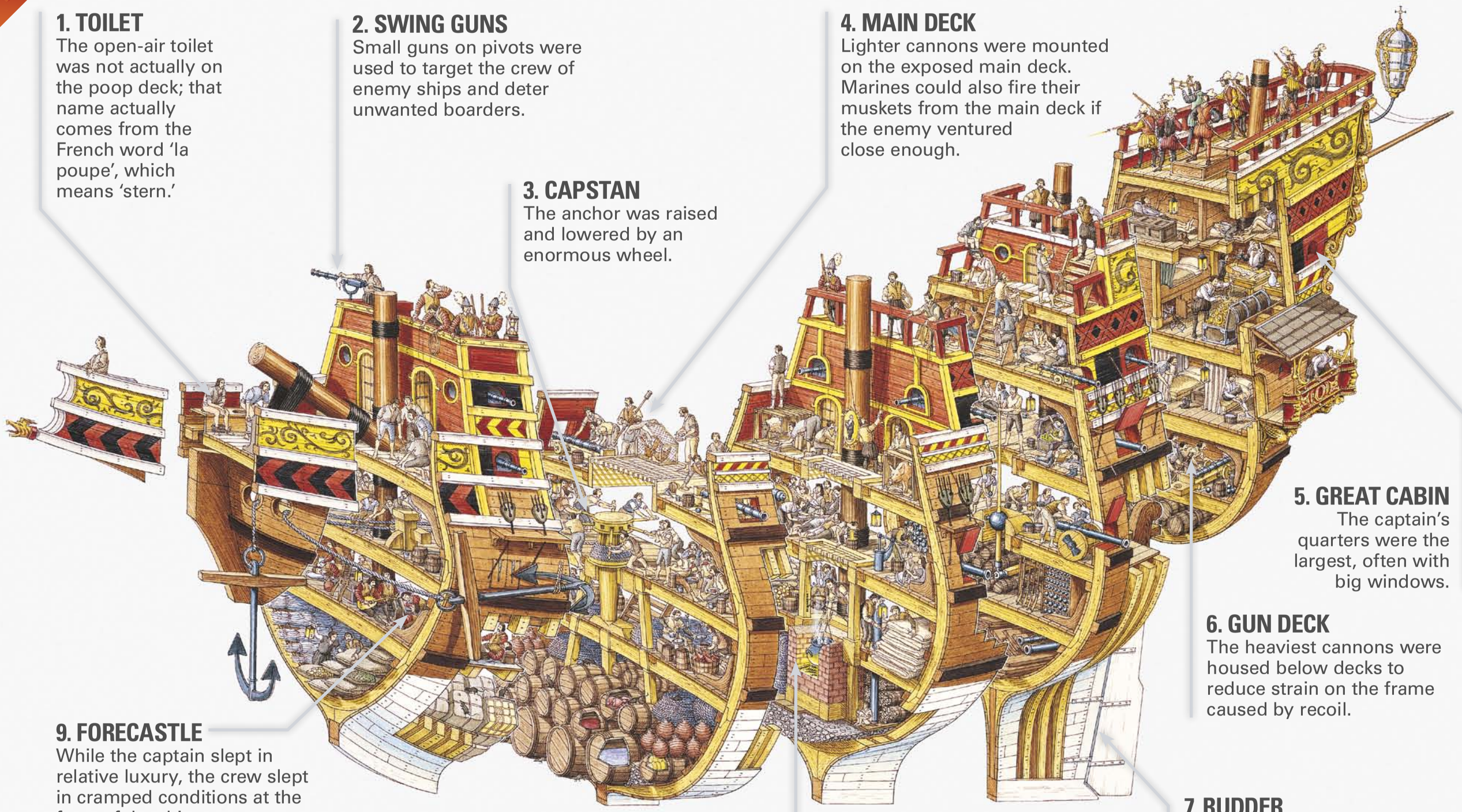
HOW DID THIS SMALL SAILING SHIP CHANGE THE WORLD?

1. TOILET
The open-air toilet was not actually on the poop deck; that name actually comes from the French word ‘la poupe’, which means ‘stern.’

2. SWING GUNS
Small guns on pivots were used to target the crew of enemy ships and deter unwanted boarders.

3. CAPSTAN
The anchor was raised and lowered by an enormous wheel.

4. MAIN DECK
Lighter cannons were mounted on the exposed main deck. Marines could also fire their muskets from the main deck if the enemy ventured close enough.



5. GREAT CABIN
The captain’s quarters were the largest, often with big windows.

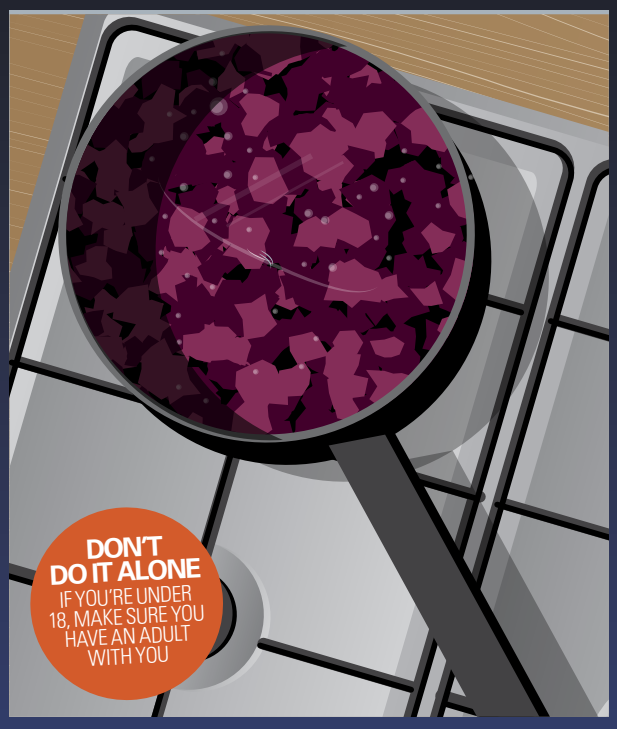
6. GUN DECK
The heaviest cannons were housed below decks to reduce strain on the frame caused by recoil.

7. RUDDER
The long rudder was another innovation of the galleon, allowing the ship greater manoeuvrability.

8. GALLEY
The kitchens had a fireplace mounted on bricks to stop the heat or sparks from setting the ship on fire.

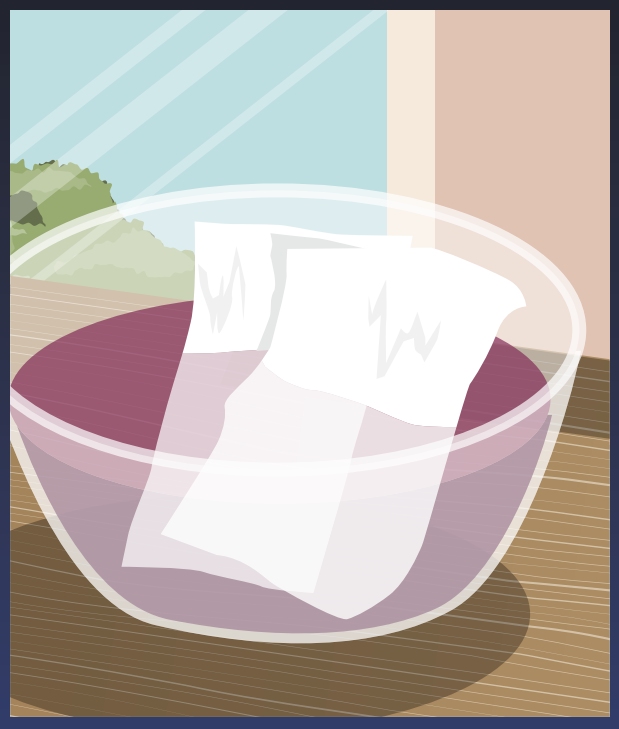
9. FORECASTLE
While the captain slept in relative luxury, the crew slept in cramped conditions at the front of the ship.

HOW TO MAKE PH PAPER



1 PREPARE YOUR CABBAGE

Chop the red cabbage into small pieces. Place them into a saucepan. Cover them with water, then heat the pan until the water boils. Turn the heat down and allow the cabbage to simmer for about 20 minutes, stirring occasionally.



2 STAIN PAPER TOWELS

Remove from the heat and pour through a strainer, collecting the purple liquid in a bowl. Once the liquid is cool enough to handle, add the paper towels and stir. Let them soak up the liquid until they've taken on the colour.

3 DRY AND CUT THE TOWEL

Take each paper towel out of the liquid and place onto a cooling rack to dry. Once the papers are dry, cut the paper towel into rectangular strips roughly 1.3cm (0.5in) wide. You are now ready to test the pH of different liquids.

4 PREPARE TEST LIQUIDS

To test your pH strips, you'll need test tubes, a stand and liquids like lemon juice, milk, vinegar and dish soap. Fill each test tube by half with a test liquid. Dip a strip into each and leave for a few minutes. Watch the tubes to see the strips change colour.

5 RECORD FINDINGS

Once you're happy that the paper towel strips have spent sufficient time in the test liquids, you can remove them. If you can't do this with your fingers, use a wooden skewer. You should record the colour of each strip immediately, as once they begin to dry the colours will often lighten and become less clear. You could even stick them onto your worksheet to keep.

ELECTRON SPEED

2.2mn m/s

AGE OF THE UNIVERSE WHEN FIRST ATOMS FORMED

380,000YRS

STATISTICOOL

ATOMS

ESTIMATED NUMBER OF ATOMS IN THE HUMAN BODY

APPROX $7X10^{27}$

ESTIMATED LIFE SPAN OF PROTON

$>10^{34}$ YEARS